TECHNISCHE UNIVERSITÄT CHEMNITZ

Institut für Physik
Physikalisches Kolloquium

Mittwoch, 22.05.2019, um 16:00 Uhr

Ort: Reichenhainer Str. 90;
Zentrales Hörsaal- und Seminargebäude,
Raum 2/N013

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Broadband Ferromagnetic Resonance Spectroscopy: The "Swiss Army Knife" for Understanding Spin-Orbit Phenomena

Modern spin-based technologies rely on multiple, simultaneous phenomena that originate from the spin-orbit interaction in magnetic systems. These include damping, magnetic anisotropy, orbital moments, and spin-orbit torques that are manifested in the spin-Hall and Rashba-Edelstein effects. While cavity based ferromagnetic resonance (FMR) spectroscopy has been used to characterize magnetic materials for many decades, recent advances in broadband and phase-sensitive FMR techniques have allowed further refinement, improved accuracy, and new measurement capability. In fact, broadband FMR techniques can now precisely measure spin-orbit torques at the thin-film level without the requirement of device fabrication [1].

Broadband FMR measurements have also improved our fundamental understanding of magnetic damping. Numerous extrinsic relaxation mechanisms can obscure the measurement of the intrinsic damping of a material. This created a challenge to our understanding of damping because experimental data were not always directly comparable to theory. As a result of the improved ability to quantify all of these relaxation mechanisms, many theoretical models have been refined. In fact, this has recently led to both the prediction [2] and discovery [3] of new materials with ultra-low magnetic damping that will be essential for future technologies based on spintronics, magnonics, spin-logic and high-frequency devices.

I will begin this lecture with a basic introduction to spin-orbit phenomena, followed by an overview of modern broadband FMR techniques and analysis methods. I will then discuss some recent successes in applying broadband FMR to improve our ability to control damping in metals and half-metals, quantify spin-orbit torques and spin-diffusion lengths in multilayers, and determine the interrelationships among damping, orbital moments, and magnetic anisotropy [4], [5]. The impact of these result on specific technologies will also be discussed.

[1] A. J. Berger, E. R. J. Edwards, H. T. Nembach, A. D. Karenowska, M. Weiler, and T. J. Silva, "Inductive detection of fieldlike and dampinglike ac inverse spin-orbit torques in ferromagnet/normal-metal bilayers," *Phys. Rev. B,* vol. 97, 094407, Mar. 2018.

[2] S. Mankovsky, D. Ködderitzsch, G. Woltersdorf, and H. Ebert, "First-principles calculation of the Gilbert damping parameter via the linear response formalism with application to magnetic transition metals and alloys," *Phys. Rev. B,* vol. 87, 014430, Jan. 2013.

[3] M. A. W. Schoen, D. Thonig, M. L. Schneider, T. J. Silva, H. T. Nembach, O. Eriksson, O. Karis, and J. M. Shaw, "Ultra-low magnetic damping of a metallic ferromagnet," *Nat. Phys.,* vol. 12, pp. 839–842, Sep. 2016.

[4] J. M. Shaw, H. T. Nembach, T. J. Silva, and C. T. Boone, "Precise determination of the spectroscopic g-factor by use of broadband ferromagnetic resonance spectroscopy," *J. Appl. Phys.,* vol. 114, 243906, Dec. 2013.

[5] J. M. Shaw, H. T. Nembach, and T. J. Silva, "Resolving the controversy of a possible relationship between perpendicular magnetic anisotropy and the magnetic damping parameter," *Appl. Phys. Lett.,* vol. 105, 062406, Aug. 2014.

Alle Zuhörer sind ab 15:45 zu Kaffee und Tee vor dem Hörsaal eingeladen.

Informationen zum Vortrag erteilt:
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